
यांत्रिक पद्धति से बुनी दोहरी-ऐंठित, षटकोणीय
तार मेष गेबियन, रिवेट मैट्रेस, रॉक फॉल नेटिंग
एवं सिविल इंजीनियरिंग प्रयोजनों के लिए
अन्य उत्पाद (जस्तीकृत इस्पात तार अथवा
पॉलिमीयरकोटिंग जस्तीकृत इस्पात
की तार) — विशिष्टि
(पहला पुनरीक्षण)

**Mechanically Woven, Double-Twisted,
Hexagonal Wire Mesh Gabions,
Revet Mattresses, Rock Fall Netting
and Other Products for Civil
Engineering Purposes (Galvanized
Steel Wire or Galvanized Steel
Wire With Polymer Coating) —
Specification
(First Revision)**

ICS 25.220.99;77.140.65

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FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Wire Ropes and Wire Products Sectional Committee had been approved by the Mechanical Engineering Division Council.

Gabions are widely used to protect land from erosion, channel lining, construction of earth retaining structures, etc. It was, therefore, felt necessary to develop an Indian Standard on mechanically woven gabions due to large use of the item for hilly areas, river beds, forest area as well as near sea beds for protection of land and minimize land erosion. This standard also specifies the requirements for revet mattresses, sack gabions, soil reinforcement facia units and rock fall netting. Based on their use, all the products may be galvanized with polymer coating therefore, those requirements have also been added in this standard.

There is a separate Indian Standard which lays down requirements for welded wire fabric gabions and gabion mattresses (metallic-coated or metallic-coated with PVC coating).

This standard does not intend to address all of the safety concerns associated with the use of gabions and gabion mattresses and other products. It is the responsibility of the manufacturers and users of this standard to establish and employ appropriate safety measures and also to ensure compliance to applicable regulations.

In the formulation of this standard, considerable guidance has been taken from ASTM A975-97 'Standard specification for double-twisted hexagonal mesh gabions and revet mattresses [metallic-coated steel wire or metallic-coated steel wire with polyvinyl chloride (PVC) coating]', EN 10223-3 'Steel wire and wire products — Part 3: Hexagonal steel wire mesh products for civil engineering purposes' and Section 2500 of MORTH — Fifth revision, 'Specifications for roads and bridges'.

The composition of the Committee responsible for the formulation of this standard is given in Annex B.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

MECHANICALLY WOVEN, DOUBLE-TWISTED, HEXAGONAL WIRE MESH GABIONS, REVET MATTRESSES AND ROCK FALL NETTING AND OTHER PRODUCTS FOR CIVIL ENGINEERING PURPOSES (GALVANIZED STEEL WIRE OR GALVANIZED STEEL WIRE WITH POLYMER COATING) — SPECIFICATION

(*First Revision*)

1 SCOPE

This standard covers gabions, revet mattresses, sack gabions, soil reinforcement facia units and rock fall netting produced from double-twisted galvanized wire mesh, and galvanized wire for lacing wire, used for manufacturing, assembling, and installation of the product. This standard also covers gabions, revet mattresses, sack gabions, soil reinforcement facia units and rock fall netting in which the wire mesh and lacing wire are polymer coated after the galvanizing. Double-twisted wire mesh for gabions, revet mattresses, sack gabions, soil reinforcement facia units and rock fall netting is produced in different classes based on type of coating.

2 REFERENCES

The standards given below contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

<i>IS No. / Other Standards</i>	<i>Title</i>
280 : 2006	Mild steel wire for general engineering purposes (<i>fourth revision</i>)
4454 (Part 1) : 2001	Steel wires for mechanical springs — Specification: Part 1 Cold drawn unalloyed steel wires (<i>third revision</i>)
4454 (Part 4) : 2001	Steel wires for mechanical springs — Specification: Part 4 Stainless steel wire (<i>second revision</i>)
4826 : 1979	Specification for hot dipped galvanized coatings on round steel wires (<i>first revision</i>)
12753 : 1989	Electrogalvanized coatings on round steel wire — Specification
13360 (Part 3/ Sec 10) : 2016	Plastics — Methods of testing: Part 3 Physical and dimensional properties, Section 10 Determination of density of non-cellular plastics — Immersion method, liquid pycnometer method and titration method
13360 (Part 3/ Sec 11) : 2016	Plastics — Methods of testing: Part 3 Physical and dimensional properties, Section 11 Determination of density of non-cellular plastics — Density gradient column method
13360 (Part 3/ Sec 12) : 2016	Plastics — Methods of testing: Part 3 Physical and dimensional properties, Section 12 Determination of density of non-cellular plastics — Gas pycnometer method
13360 (Part 5/ Sec 1) : 2018	Plastics — Methods of testing: Part 5 Mechanical properties, Section 1 Determination of tensile properties — General principles (<i>first revision</i>)
13360 (Part 5/ Sec 11) : 2013	Plastics — Methods of testing: Part 5 Mechanical properties, Section 11 Determination of indentation hardness of plastics by means of durometer (shore hardness)
13360 (Part 8/ Sec 14) : 2018	Plastics — Methods of testing: Part 8 Permanence/Chemical properties, Section 14 Determination of the effects of exposure to damp heat, water spray and salt mist (<i>first revision</i>)
ASTM A975-97	Standard specification for double-twisted hexagonal mesh gabions and revet mattresses [metallic-coated steel wire or metallic-coated steel wire with polyvinyl chloride (PVC) coating]
EN 10223-3 : 2013	Steel wire and wire products — Part 3: hexagonal steel wire mesh products for civil engineering purposes.

<i>IS No./Other Standards</i>	<i>Title</i>
MORTH 2500 : 2013	Specifications for Roads and Bridges (<i>fifth revision</i>).
ISO 4892-3 : 2016	Plastics — Methods of exposure to laboratory light sources — Part 3: Fluorescent UV lamps
ISO 37 : 2017	Rubber, vulcanized or thermoplastic — Determination of tensile stress-strain properties
ISO 974 : 2000	Plastics — Determination of the brittleness temperature by impact

3 TERMINOLOGY

For the purpose of this standard, following definitions shall apply.

3.1 Gabion — A wire mesh container of variable sizes, uniformly partitioned into internal cells, interconnected with other similar units, and filled with stone at the project site to form flexible, permeable monolithic structures for earth retaining and erosion control purposes, such as retaining walls, sea walls, channel linings, revetments, offshore bunds, dykes and weirs (*see Fig. 1 to Fig. 5*).

3.2 Revet Mattress — Revet mattress a wire mesh container uniformly partitioned into internal cells with relatively smaller height in relation to other dimensions, having smaller mesh openings than the mesh used for gabions, revet mattresses are generally used for riverbank protection and channel linings (*see Fig. 6*).

3.3 Rock Fall Netting — A wire mesh supplied in the form of rolls which is used to prevent rocks and debris from falling on to roads, railways or any other area which needs protection (*see Fig. 7*).

3.4 Sack Gabions — A cylindrical double twist steel wire mesh unit with a lateral opening to allow the stone filling or geotextile encased sand filling at site. (*see Fig. 8*).

3.5 Soil Reinforcement Units for Retaining Structures — Double twisted steel wire mesh units used for reinforced soil structures and slope consolidation.

3.5.1 For structures with vertical facing (*see Fig. 9*), units are made with hexagonal wire mesh continuous base panel for the reinforcement and the facing portion of the structure.

3.5.2 for the structures with inclined vegetative facing (*see Fig. 10*), units are made with hexagonal wire mesh base reinforcement, provided (or made) with a welded mesh panel for facing, a geotextile for soil retention and metallic ties for installation procedures.

3.6 Double-Twisted Wire Mesh — A non-raveling mesh made by twisting continuous pairs of wires through three one-half turns (commonly called double-twisted) to form hexagonal shaped openings which are then interconnected to adjacent wires to form hexagonal openings.

3.7 Selvedge Wire — A terminal wire used to edge the wire mesh perpendicular to the double twist by mechanically wrapping the mesh wires around it at least 2.5 times (*see Fig. 1*).

3.8 Edge Wire — A terminal wire of the same diameter as the selvedge wire used to edge the wire mesh parallel to the double twist by continuously weaving it mechanically into the wire mesh (*see Fig. 1*).

3.9 Lacing Wire — A galvanized wire or galvanized wire with polymer coating used to assemble and interconnect empty units, to close and secure stone-filled units, and for internal stiffeners (*see Fig. 2 and Fig. 3*).

3.10 Spenax Fasteners/Overlapping Fasteners/Steel Rings — A galvanized or stainless-steel ring which is used instead of, or to compliment lacing wire for basket assembly and installation (*see Fig. 4*).

3.11 Diaphragm — An internal partition made of same wire mesh panel in a gabion/revet mattress/sack gabion and soil reinforcement facia units that is attached to the bottom, the sides, and, after the units are packed with stones, to the lid of the cage (*see Fig. 5*).

3.12 Bracing Wire/Stiffener — A length of galvanized wire or galvanized wire with polymer coating used for support of facing by connecting the front panel to the back panel of a gabion and having the same diameter as the lacing wire (*see Fig. 11*).

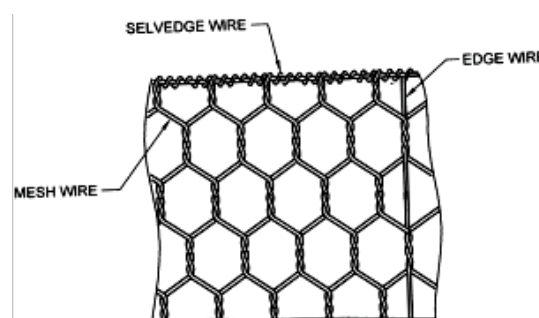


FIG. 1 MESH WIRE, SELVEDGE AND EDGE WIRE

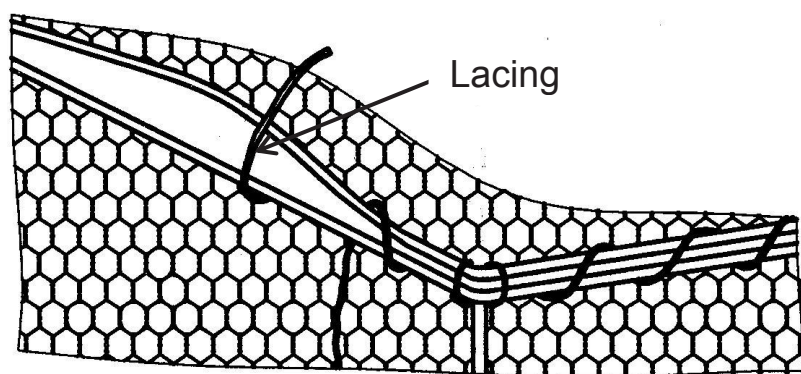


FIG. 2 LACING WIRE FOR TYING

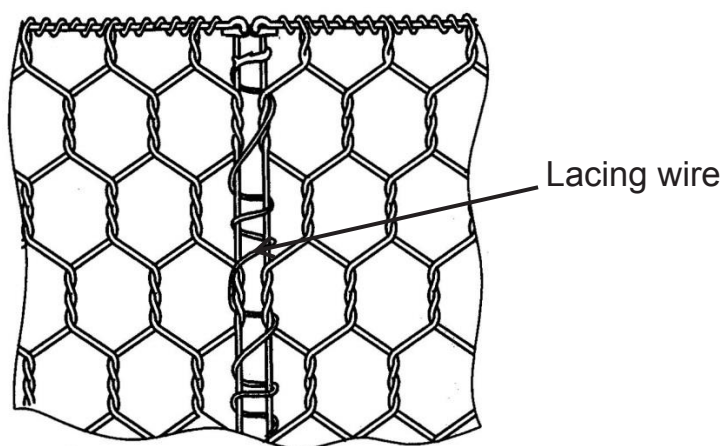


FIG. 3 LACING WIRE FOR TYING ADJACENT PANELS IN SINGLE AND DOUBLE LOOP FASHION

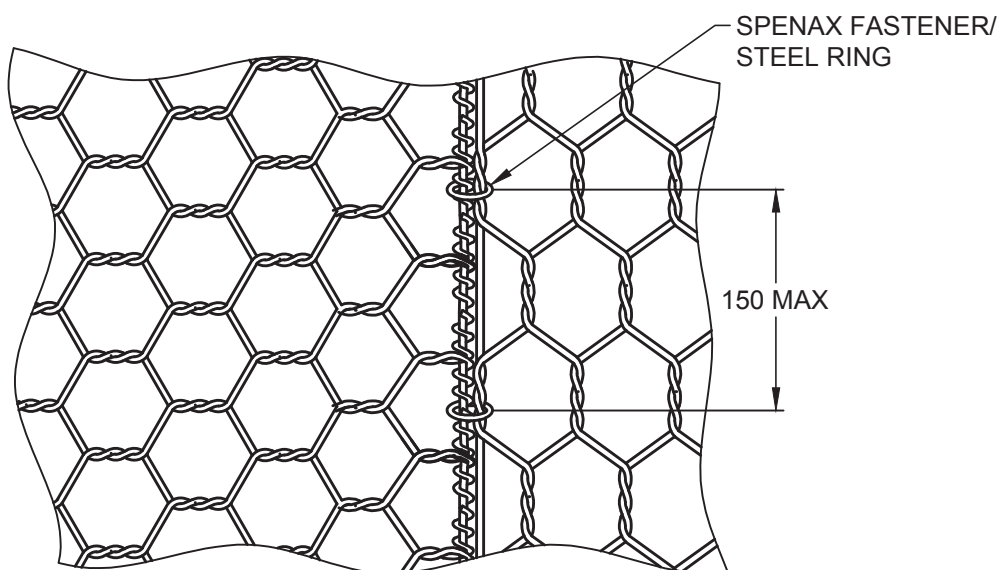


FIG. 4 RINGS FOR JOINING ADJACENT PANELS INSTEAD OR WITH LACING WIRE

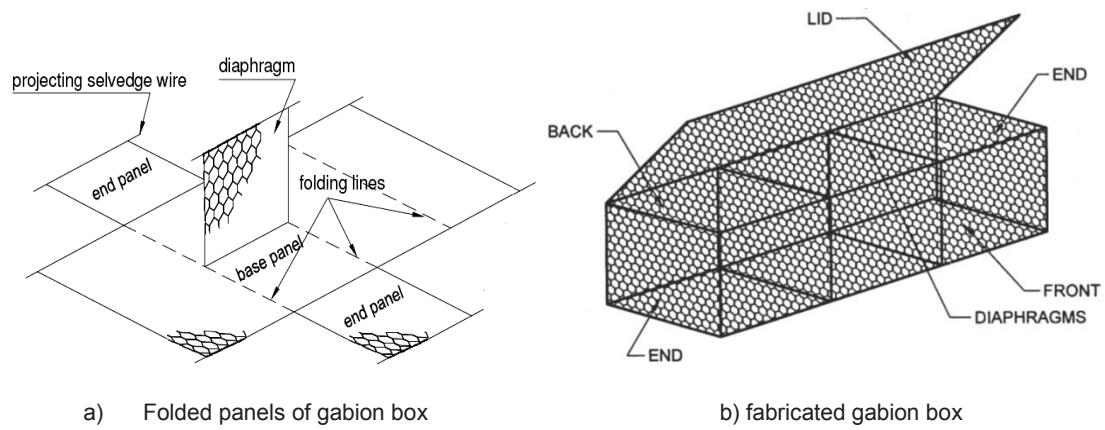


FIG. 5 GABION BOX

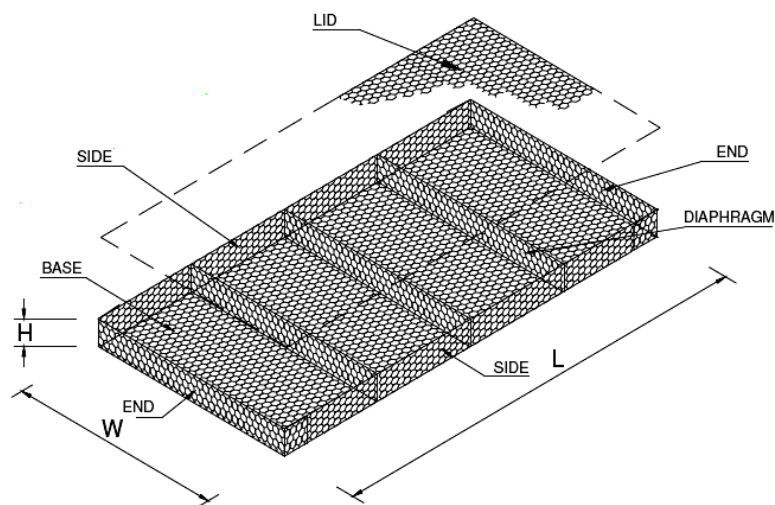


FIG. 6 REVET MATTRESS

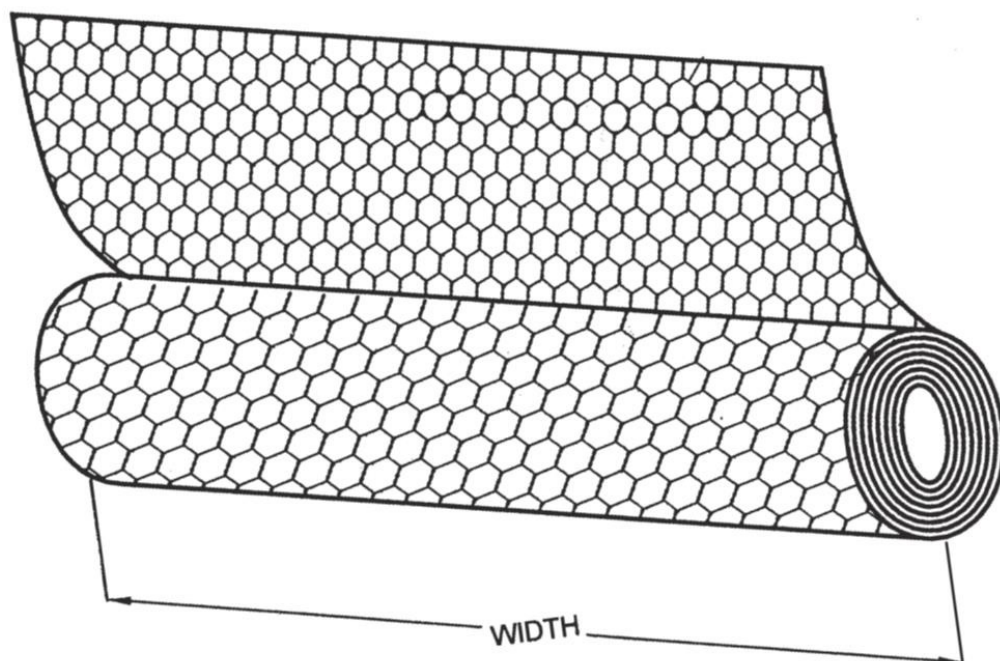
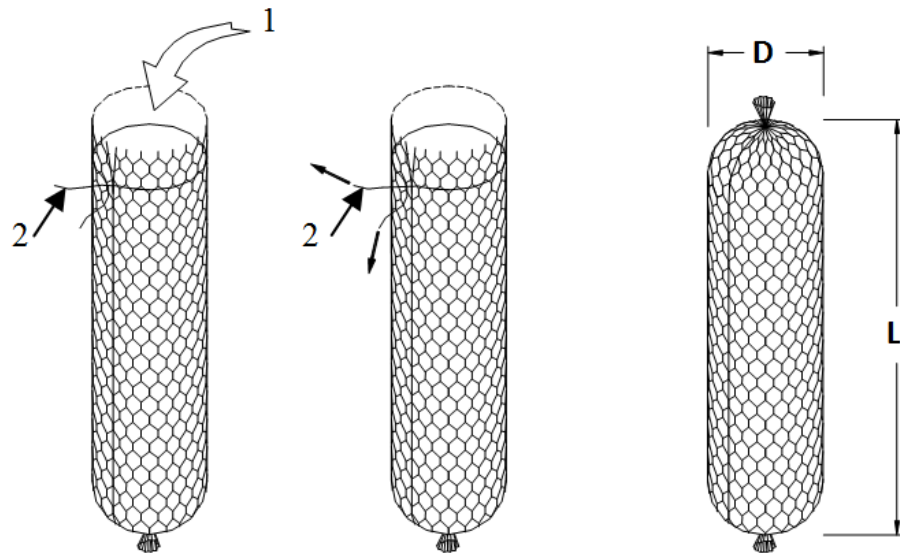
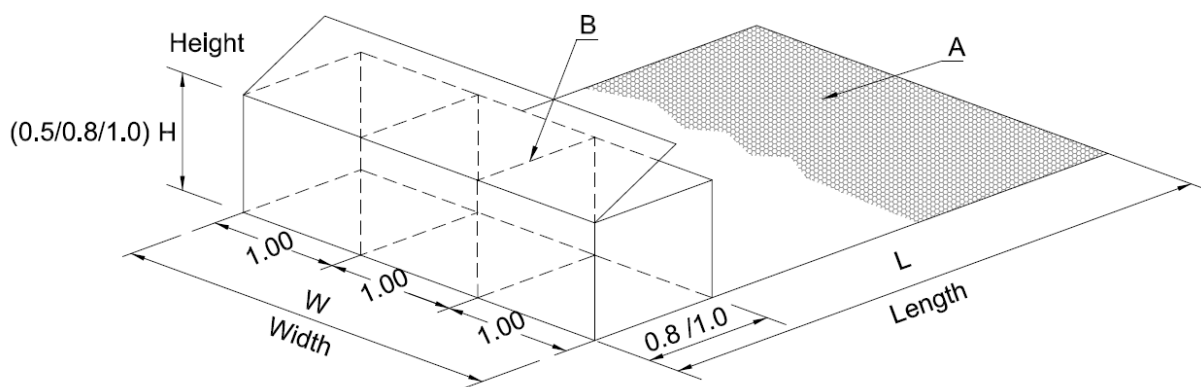


FIG. 7 ROCKFALL NETTING

**Key**

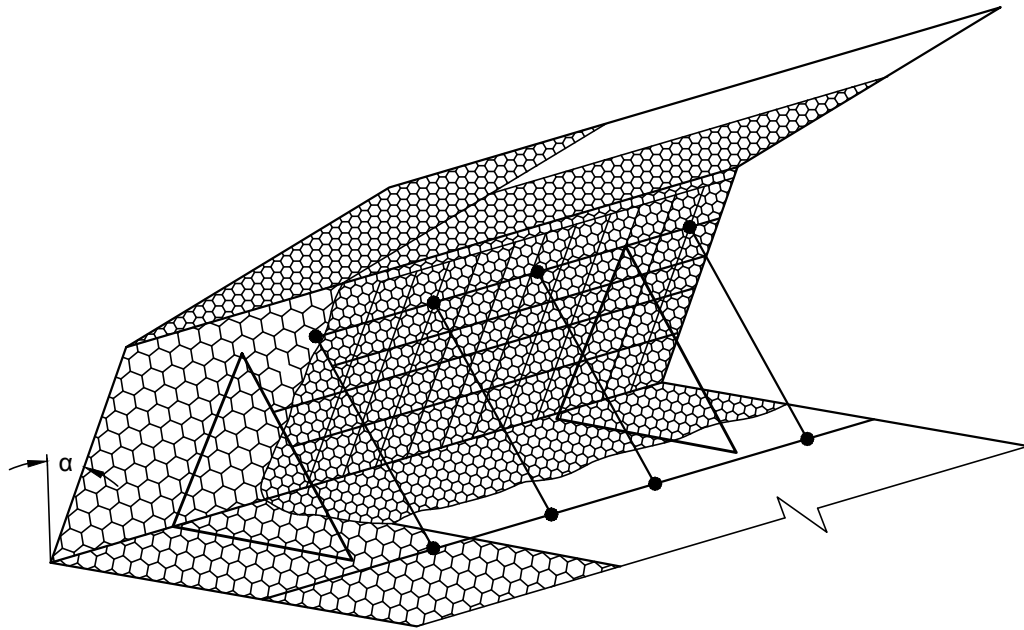
- 1 filling
- 2 lacing wire
- D diameter of the sack gabions
- L length of sack gabions

FIG. 8 SACK GABION

**Key**

- A base panel
- B diaphragm
- H Height
- L Length
- W Width

FIG. 9 FACIA UNITS FOR VERTICAL FACING REINFORCED SOIL STRUCTURES



KEY

α VARIABLE BETWEEN 20° AND 45°

FIG. 10 FACIA UNITS FOR INCLINED FACING REINFORCED SOIL STRUCTURES

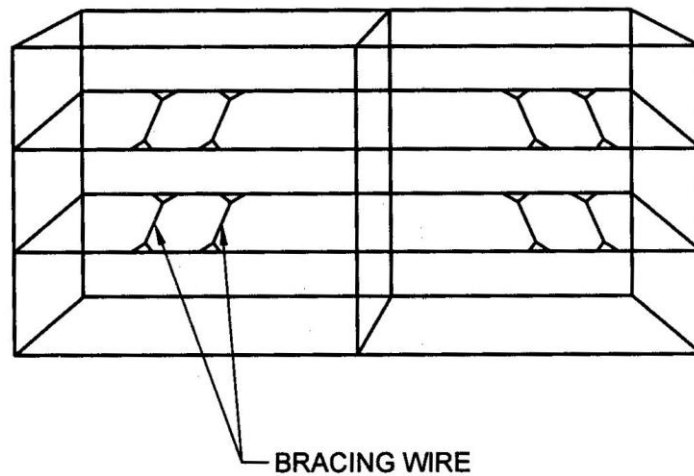


FIG. 11 BRACING WIRE/STIFFNER

3.13 Mesh Size — The average distance, measured at right angles between twisted sides over 10 meshes (see Fig. 12).

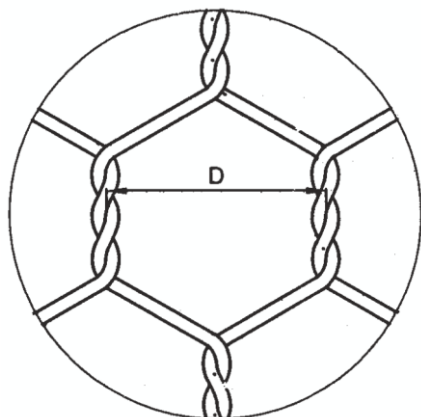


FIG. 12 MESH TYPE AND NOMINAL SIZE ‘D’

4 CLASSIFICATIONS

Double-twisted wire mesh gabions, revet mattresses, rock fall netting, sack gabion and facia units of reinforced soil structures are classified according to coating, as follows:

- a) *Class 1* — Consists of double-twisted wire mesh made from wire which is zinc or zinc alloy coated before being double-twisted into mesh. Fasteners, lacing wire and stiffeners are produced from zinc or zinc alloy coated wire; and
- b) *Class 2* — Consists of double-twisted wire mesh, lacing wire and stiffeners as Class 1 and over coated with polymer (PVC/PA6/other advanced polymers). Fastener shall be of stainless steel wire.

Refer Annex A for the description of environment of installation site, coating wire requirements for different types of galvanization and polymeric coatings.

5 MATERIALS AND MANUFACTURE

5.1 The wire used in the manufacture of double-twisted mesh for use in gabions, revet mattresses, rock fall netting, sack gabions and facia units of reinforced soil structures shall confirm to IS 280 and to the requirement of 5.1.1 or 5.1.2 as appropriate for the class ordered except that the tensile strength shall conform to 6.1.

5.1.1 Class 1 double-twisted mesh shall be manufactured from zinc or zinc alloy coated steel wire conforming

to IS 4826, heavily coated and soft type or IS 12753 (heavy coated).

5.1.2 Class 2 double-twisted mesh shall be manufactured from the same type of galvanized steel wire as Class 1 with an additional polymer coating extruded onto the galvanized steel wire. The polymer coating shall conform to the requirements given in 7.2.

5.2 Gabions, revet mattresses, sack gabions and facia units of reinforced soil structure shall be manufactured with all components mechanically connected at the production facility with the exception of the mattress lid which is produced separately from the base. All gabions, revet mattresses, rock fall netting, sack gabions and facia units of reinforced soil structure shall be supplied in the collapsed form, either folded and bundled or rolled for shipping.

5.3 Lacing wire and stiffeners shall be made of wire having the same coating material as the double-twisted wire mesh furnished on the order and conforming to IS 4826 or IS 12753 (heavy coated) and tensile strength conforming to 6.1.

5.4 The spacing of the steel rings to compliment lacing wire during all phases of assembly and installation shall be in accordance with spacing based on pull apart resistance for mesh when tested in accordance with 13.1.2 of ASTM A975 with a nominal spacing of 100 mm and not to exceed 150 mm.

5.4.1 Galvanized Rings

Fasteners made from galvanized steel wire of 3 mm diameter shall be used for products of Class 1 type mesh. The galvanized steel wire for fastener shall conform to SM Grade of IS 4454 (Part 1) with minimum tensile strength of 1550 MPa and shall be galvanized with mass of zinc coating not less than that given in Table 5.

5.4.2 Stainless Steel Fasteners

Fasteners made from stainless steel wire of 3 mm diameter shall be used for products of Class 2 type mesh. The stainless steel wire for fastener shall conform to Grade 1 steel of IS 4454 (Part 4) with minimum tensile strength of 1550 MPa.

5.5 The standard sizes of gabion boxes, revet mattresses, sack gabions and facia units of reinforced soil rock fall netting are given in Tables 1, 2, 3, 4, 5 and 6 respectively. Any other size as agreed to between the purchaser and the manufacturer.

Table 1 Mesh and Box Characteristics for Gabions
(*Clauses 5.5, 8.1, 8.2, 8.9 and 12.4*)

Sl. No.	Characteristics	Mesh Type					
		10 × 12 D = 100 mm			8 × 10 D = 80 mm		
		Only Zinc / Zinc Alloy ² coated		Zinc / Zinc Alloy ² + Polymer coated	Only Zinc / Zinc Alloy ² coated		Zinc / Zinc Alloy ² + Polymer coated
(1.0)	(2.0)	(3.0)	(4.0)	(5.0)	(6.0)	(7.0)	(8.0)
i)	Mesh wire dia, mm	2.70	3.00	2.70/3.70 ¹⁾	2.70	3.00	2.70/3.70 ¹⁾
ii)	Edge/Selvedge wire dia, mm	3.40	3.90	3.40/4.40 ¹⁾	3.40	3.90	3.40/4.40 ¹⁾
iii)	Lacing wire dia, mm	2.20	2.20	2.20/3.20 ¹⁾	2.20	2.20	2.20/3.20 ¹⁾
iv)	Polymer coating thickness, mm	N. A		Nominal — 0.50 Minimum — 0.40	NA		Nominal — 0.50 Minimum — 0.40
v)	Typical sizes						
	Length × Width × Height (m)	4 × 1 × 1 (3 Nos.), 3 × 1 × 1 (2 Nos.), 2 × 1 × 1 (1 No.), 1.5 × 1 × 1 (0 No.), 2 × 1 × 0.5 (1 No.),					
	(Number of diaphragms)	3 × 1 × 0.5 (2 Nos.), 4 × 1 × 0.5 (3 Nos.), 2 × 1 × 0.3 (1 No.), 3 × 1 × 0.3 (2 Nos.), 4 × 1 × 0.3 (3 Nos.)					
vi)	Tolerances in size of gabion boxes	Length and Width... ± 5 percent; Height > 0.3 m... ± 5 percent and Height < 0.3 m... ± 10 percent					

¹⁾ Internal diameter/External diameter of polymer coated wire.

²⁾ Zinc Alloy shall consist of 90 percent Zinc + 10 percent Aluminium or 95 percent Zinc + 5 percent Aluminium

Table 2 Mesh and Box Characteristics for Revet Mattresses

(Clauses 5.5, 8.1, 8.2, 8.9 and 12.4)

Sl. No.	Characteristics	Mesh Type	
		Only Zinc / Zinc Alloy ² coated	Zinc / Zinc Alloy ² +Polymer coated
(1.0)	(2.0)	(3.0)	(4.0)
i)	Mesh wire dia, mm	2.20	2.20/3.20 ¹⁾
ii)	Edge/Selvedge wire dia, mm	2.70	2.70/3.70 ¹⁾
iii)	Lacing wire dia, mm	2.20	2.20/3.20 ¹⁾
iv)	Polymer coating thickness, mm	N.A	Nominal — 0.50 Minimum — 0.40
v)	Typical sizes	$4 \times 2 \times 0.17$ (3 Nos.), $3 \times 2 \times 0.17$ (2 Nos.), $2 \times 2 \times 0.17$ (1 No.), $4 \times 2 \times 0.23$ (3 Nos.), $3 \times 2 \times 0.23$ (2 Nos.), $2 \times 2 \times 0.23$ (1 No.), $4 \times 2 \times 0.30$ (3 Nos.), $3 \times 2 \times 0.30$ (2 Nos.), $2 \times 2 \times 0.30$ (1 No.)	
	Length × Width × Height (m)		
	(Number of diaphragms)		
vi)	Tolerances in size of Revet mattresses	Length and Width... ± 5 percent; Height < 0.3 m... ± 10 percent and	

¹⁾ Internal diameter/External diameter of polymer coated wire.

²⁾ Zinc Alloy shall consist of 90 percent zinc + 10 percent Aluminium or 95 percent Zinc + 5 percent Aluminium

Table 3 Mesh and Box Characteristics for Sack Gabions(*Clauses 5.5, 8.1, 8.2, 8.9 and 12.4*)

Sl. No.	Characteristics	Mesh Type					
		10 × 12 D = 100 mm			8 × 10 D = 80 mm		
		Only Zinc / Zinc Alloy ² coated		Zinc / Zinc Alloy ² + Polymer coated	Only Zinc / Zinc Alloy ² coated		Zinc / Zinc Alloy ² + Polymer coated
		(3.0)	(4.0)	(5.0)	(6.0)	(7.0)	(8.0)
(1.0)	(2.0)	(3.0)	(4.0)	(5.0)	(6.0)	(7.0)	(8.0)
i)	Mesh wire dia, mm	2.70	3.00	2.70/3.70 ¹⁾	2.70	3.00	2.70/3.70 ¹⁾
ii)	Edge/Selvedge wire dia, mm	3.40	3.90	3.40/4.40 ¹⁾	3.40	3.90	3.40/4.40 ¹⁾
iii)	Lacing wire dia, mm	2.20	2.20	2.20/3.20 ¹⁾	2.20	2.20	2.20/3.20 ¹⁾
iv)	Polymer coating thickness, mm	N. A		Nominal — 0.50 Minimum — 0.40	NA		Nominal — 0.50 Minimum — 0.40
v)	Typical sizes						
	Length × Diameter (m)	1.5 × 0.74, 2 × 0.96					
vi)	Tolerances in size of units	Length and Diameter... ± 5 percent; Height > 0.3 m... ± 5 percent and Height < 0.3 m... ± 10 percent					

¹⁾ Internal diameter/External diameter of polymer coated wire.²⁾ Zinc Alloy shall consist of 90 percent zinc + 10 percent Aluminium or 95 percent Zinc + 5 percent Aluminium

Table 4 Mesh and Unit Characteristics for Vertical Facing Units of Reinforced Soil Structures
(*Clauses 5.5, 8.1, 8.2, 8.9 and 12.4*)

Sl. No.	Characteristics	Mesh Type	
		10×12 $D = 100 \text{ mm}$ Zinc / Zinc Alloy ² + Polymer coated	8×10 $D = 80 \text{ mm}$ Zinc / Zinc Alloy ² + Polymer coated
(1.0)	(2.0)	(3.0)	(4.0)
i)	Mesh wire dia, mm	2.70/3.70 ¹⁾	2.70/3.70 ¹⁾
ii)	Edge/Selvedge wire dia, mm	3.40/4.40 ¹⁾	3.40/4.40 ¹⁾
iii)	Lacing wire dia, mm	2.20/3.20 ¹⁾	2.20/3.20 ¹⁾
iv)	Polymer coating thickness, mm	Nominal — 0.50	Nominal — 0.50
		Minimum — 0.40	Minimum — 0.40
v)	Typical sizes		
	Length $\times$ Width $\times$ Height (m)	$3 \times 2 \times 0.5$ (1 No.), $3 \times 3 \times 0.5$ (2 Nos.), $4 \times 2 \times 0.5$ (1 No.), $4 \times 3 \times 0.5$ (2 Nos.), $5 \times 2 \times 0.5$ (1 No.), $5 \times 3 \times 0.5$ (2 Nos.), $6 \times 2 \times 0.5$ (1 No.), $6 \times 3 \times 0.5$ (2 Nos.)	
	(Number of diaphragms)	$3 \times 2 \times 1$ (1 No.), $3 \times 3 \times 1$ (2 Nos.), $4 \times 2 \times 1$ (1 No.), $4 \times 3 \times 1$ (2 Nos.), $5 \times 2 \times 1$ (2 Nos.), $5 \times 3 \times 1$ (2 Nos.) $3 \times 2 \times 1$ (1 No.), $6 \times 3 \times 1$ (2 Nos.) $3 \times 2 \times 0.8$ (1 No.), $3 \times 3 \times 0.8$ (2 Nos.), $4 \times 2 \times 0.8$ (1 No.), $4 \times 3 \times 0.8$ (2 Nos.), $5 \times 2 \times 0.8$ (2 Nos.), $5 \times 3 \times 0.8$ (2 Nos.), $3 \times 2 \times 0.8$ (1 No.), $6 \times 3 \times 0.8$ (2 Nos.)	
vi)	Tolerances in size of Units	Length and Width... ± 5 percent; Height $> 0.3 \text{ m}$... ± 5 percent and Height $< 0.3 \text{ m}$... ± 10 percent	

¹⁾ Internal diameter/External diameter of polymer coated wire.

²⁾ Zinc Alloy shall consist of 90 percent zinc + 10 percent Aluminium or 95 percent Zinc + 5 percent Aluminium

Table 5 Hexagonal Wire Mesh and Unit Characteristics for Inclined Facing Units of Reinforced Soil Structures

(*Clauses 5.5, 8.1, 8.2, 8.9 and 12.4*)

Sl. No.	Characteristics	Mesh Type	
		10×12 $D = 100 \text{ mm}$ Zinc / Zinc Alloy ² + Polymer coated	8×10 $D = 80 \text{ mm}$ Zinc / Zinc Alloy ² + Polymer coated
(1.0)	(2.0)	(3.0)	(4.0)
i)	Mesh wire dia, mm	2.70/3.70 ¹⁾	2.70/3.70 ¹⁾
ii)	Edge/Selvedge wire dia, mm	3.40/4.40 ¹⁾	3.40/4.40 ¹⁾
iii)	Lacing wire dia, mm	2.20/3.20 ¹⁾	2.20/3.20 ¹⁾
iv)	Polymer coating thickness, mm	Nominal — 0.50 Minimum — 0.40	Nominal — 0.50 Minimum — 0.40
v)	Typical sizes		
	Length $\times$ Width $\times$ Height (m)	$3 \times 2 \times 0.63$ (45), $3 \times 2 \times 0.76$ (60), $3 \times 2 \times 0.83$ (70), $3 \times 3 \times 0.63$ (45), $3 \times 3 \times 0.76$ (60), $3 \times 3 \times 0.8$ (65), $3 \times 3 \times 0.83$ (70), $4 \times 2 \times 0.63$ (45), $4 \times 2 \times 0.76$ (60), $4 \times 2 \times 0.80$ (65), $4 \times 2 \times 0.83$ (70), $4 \times 3 \times 0.63$ (45), $4 \times 3 \times 0.76$ (65), $4 \times 3 \times 0.83$ (70), $5 \times 2 \times 0.63$ (45), $5 \times 2 \times 0.76$ (60), $5 \times 2 \times 0.80$ (65), $5 \times 2 \times 0.83$ (70), $5 \times 3 \times 0.63$ (60), $5 \times 3 \times 0.8$ (65), $5 \times 3 \times 0.83$ (70), $6 \times 2 \times 0.63$ (45), $6 \times 2 \times 0.76$ (60), $6 \times 2 \times 0.80$ (65), $6 \times 2 \times 0.83$ (70), $6 \times 3 \times 0.63$ (45), $6 \times 3 \times 0.80$ (65), $6 \times 3 \times 0.83$ (70),	
vi)	Tolerances in size of Units	Length and Width... ± 5 percent; Height $> 0.3 \text{ m}$... ± 5 percent and Height $< 0.3 \text{ m}$... ± 10 percent	

¹⁾ Internal diameter/External diameter of polymer coated wire.

²⁾ Zinc Alloy shall consist of 90 percent zinc + 10 percent Aluminium or 95 percent Zinc + 5 percent Aluminium

Table 6 Mesh and Roll Characteristics for Rockfall Netting

(Clauses 5.5, 8.1, 8.2, 8.11 and 12.4)

Sl. No.	Characteristics	Mesh Type							
		10 × 12 D = 100 mm			8 × 10 D = 80 mm			6 × 8 D = 60 mm	
		Only Zinc / Zinc Alloy ² coated		Zinc / Zinc Alloy ² + Polymer coated	Only Zinc / Zinc Alloy ² coated		Zinc / Zinc Alloy ² + Polymer coated	Only Zinc / Zinc Alloy ² coated	Zinc / Zinc Alloy ² + Polymer coated
		(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
i)	Mesh wire dia, mm	2.70	3.00	2.70/3.70 ¹⁾	2.70	3.00	2.70/3.70 ¹⁾	2.2	2.2/3.2 ¹⁾
ii)	Edge/Selvedge wire dia, mm	3.40	3.90	3.40/4.40 ¹⁾	3.40	3.90	3.40/4.40 ¹⁾	2.7	2.7/3.7 ¹⁾
iii)	Lacing wire dia, mm	2.20	2.20	2.20/3.20 ¹⁾	2.20	2.20	2.20/3.20 ¹⁾	2.20	2.20/3.20 ¹⁾
iv)	Polymer coating thickness, mm	NA		Nominal — 0.50 Minimum — 0.40	NA		Nominal — 0.50 Minimum — 0.40	NA	Nominal — 0.50 Minimum — 0.40
v)	Typical size of rolls								
	Length × Width (m)	25 × 2, 25 × 3 and 25 × 4							
vi)	Tolerances in size of netting rolls	Length and Width... ± 5 percent; Height > 0.3 m... ± 5 percent and Length + 1.0m to -0.0m, width + “D”							

¹⁾ Internal diameter/External diameter of Polymer coated wire.

²⁾ Zinc Alloy shall consist of 90 percent zinc + 10 percent Aluminium or 95 percent Zinc + 5 percent

Table 7 Strength Requirements of Hexagonal Wire Mesh Panel for all Relevant Products
(Clauses 6.2 and 11.2)

Sl. No.	Characteristics	Mesh Type						
		10 × 12 D = 100 mm		8 × 10 D = 80 mm		6 × 8 D = 60mm		
		Only zinc / Zinc Alloy ² coated	Zinc / Zinc Alloy ² + Polymer coated	Only Zinc / Zinc Alloy ² coated	Zinc / Zinc Alloy ² + Polymer coated	Only Zinc / Zinc Alloy ² coated	Only Zinc / Zinc Alloy ² coated	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	Mesh wire dia, mm	2.70	3.00	2.70/3.70 ¹⁾	3.00	2.70/3.70 ¹⁾	2.20	2.2/3.2 ¹⁾
ii)	Tensile Strength Parallel to twist, kN/m	32.00	40.00	32.00	51.00	42.50	33.50	34.00
iii)	Tensile Strength Perpendicular to twist, kN/m	15.50	20.50	15.50	26.50	20.50	13.00	13.00
iv)	Selvedge Strength, kN/m	10.20	11.22	10.20	20.40	16.32	10.20	10.20
v)	Punch Strength, kN	17.80	19.58	17.8	26.70	21.36	17.80	17.80
vi)	Panel to panel connection (lacing wire/ fasteners), kN/m	10.20	11.22	10.20	20.40	16.32	10.20	10.20

¹⁾ Internal diameter/External diameter of Polymer coated wire.

²⁾ Zinc Alloy shall consist of 90 percent zinc + 10 percent Aluminium or 95 percent Zinc + 5 percent

6 MECHANICAL PROPERTIES

6.1 Tensile Strength

The tensile strength of wire used for double-twisted mesh, lacing wire, and stiffener, when tested shall be in accordance with the requirements of IS 280 for soft wire (350-550 MPa) at a minimum elongation of 10 percent, performed on a gauge length of test specimen as 200 mm.

6.2 Mesh Panel Strength

The minimum strength requirements of the mesh, when tested in accordance with 12.1, shall be as shown in Table 7.

When the mesh is provided with organic coating, a sample shall be tested (According to 12.1) at 50 percent of nominal tensile strength without showing cracks in the organic coating within the double twist region

7 PHYSICAL PROPERTIES

7.1 Zinc/Zinc Alloy Coating

7.1.1 Mass of Zinc/Zinc Alloy Coating

The coating mass shall conform to the requirements of IS 4826 heavily coated and soft type. The zinc alloy shall consist of 90 percent Zinc + 10 percent Aluminium (or) 95 percent Zinc + 5 percent Aluminium. See Table 7 for the minimum mass of zinc/zinc alloy coating for different wire sizes.

Table 8 Minimum mass of Zinc/Zinc Alloy coating for Heavily Coated, Soft Type for Different Wire Sizes Used in Gabion, Sack Gabions, Revet Mattresses, Rockfall netting and fascia units for reinforced soil structures
(Clause 5.4.1 and 7.1.1)

SI No	Nominal Diameter of Galvanized Wire mm	Mass of Zinc/Zinc Alloy coating g/m ²	Permitted Tolerances on wire diameters mm
(1)	(2)	(3)	(4)
i)	2.00	240	±0.05
ii)	2.20	240	±0.06
iii)	2.40	260	±0.06
iv)	2.70	260	±0.07
v)	3.00	270	±0.08
vi)	3.40	270	±0.09
vii)	3.90	280	±0.10

7.1.2 Adhesion of Zinc/Zinc Alloy Coating

The Zinc/Zinc Alloy coating shall remain adherent to the steel wire and conform to IS 4826 such that zinc/zinc alloy coating does not flake off, nor crack to such an extent that there is possibility of removing any

zinc/zinc alloy by rubbing with bare fingers, the use of finger nails being not allowed.

7.1.3 Ageing and Corrosion Resistance

a) 95 percent Zn + 5 percent Al

When subjected to test in sulphur dioxide environment according to procedures in EN ISO 6988 after 28 cycles of discontinuous test, the test samples shall not show more than 5 percent of DBR (Dark Brown Rust)

b) 90 percent Zn + 10 percent Al

When subjected to test in sulphur dioxide environment according to procedures in EN ISO 6988 after 56 cycles of discontinuous test, the test samples shall not show more than 5 percent of DBR (Dark Brown Rust)

7.2 Polymer for Coating

The initial properties of polymer coating material shall conform to the following requirements:

- Specific gravity* — In the range from 1.30 to 1.35 when tested in accordance with IS 13360 (Part 3/ Sec 10, 11 and 12) : 2016.
- Tensile strength* — Not less than 20.6 MPa when tested in accordance with IS 13360 (Part 5/Sec 1).
- Hardness* — Shore 'D' between 50 and 60, when tested in accordance with IS 13360 (Part 5/Sec 11).
- Resistance of polymer coating to sodium chloride solution* — When polymer coated wire is tested in accordance with 12.4 there shall be no loss of mass.
- Salt spray exposure* — The PVC shall be subjected to 3 000 h of salt spray exposure in accordance with IS 13360 (Part 8/Sec 14). After the salt spray test, the PVC Coating shall not show cracks nor noticeable change of colour, or blisters or splits. In addition, the specific gravity and tensile strength shall not change more than 6 percent and 25 percent respectively from their initial values.
- Modulus of Elasticity* — Not less than 18.6 MPa [2700 psi] when tested in accordance with Test Methods ISO 37 : 2017.
- Brittleness Temperature* — Not higher than -9°C [15°F], or lower temperature when specified by the purchaser, when tested in accordance with Test Method ISO 974 : 2000 (*see Note*).

Applicability of this note needs to be checked based on ISO 974.

NOTE — The maximum brittleness temperature should be at least 8°C [15°F] below the minimum temperature at which the gabions will be filled.

- Resistance to UV rays* — Polymer mechanical characteristics (elongation and tensile strength) of the base compound after a UV rays exposure of 2 500 hours QUV-A (ISO 4892-3 : 2016 exposure mode 1) cannot change more than 25% from the initial tests.

8 DIMENSIONS AND TOLERANCES

8.1 The diameter of galvanized steel wire shall conform to the values as per Table 1 for gabions, Table 2 for revet mattresses, Table 3 for sack gabions, Table 4 for vertical facing units of reinforced soil structures, Table 5 for inclined facing units of reinforced soil structure and Table 6 for rock fall netting. The diameter of the wires shall also conform to the tolerance values as shown in col 4 of Table 5 as per IS 280 for galvanized steel wire.

8.2 The minimum and nominal thickness of polymer coating uniformly applied in a quality workmanlike manner shall be as shown in Tables 1, 2, 3, 4, 5, 6.

8.3 Gabions shall be manufactured with a 10×12 or 8×10 mesh type (*see* Fig. 5) having a nominal mesh opening size as per Table 9. Dimensions are measured at right angles to the centre axis of the opening and parallel to the twist along the same axis.

8.4 Revet mattresses shall be manufactured with a 6×8 mesh type (*see* Fig. 6) having a nominal mesh opening size as per Table 9. Dimensions are measured at right angles to the centre axis of the opening and parallel to the twist along the same axis.

Table 9 Mesh Types and Sizes
(Clauses 5.4.1, 8.3, 8.4, 8.8 and 8.9)

Sl No.	Mesh Type	'D' Nominal Size	Tolerances
(1)	(2)	(3)	(4)
i)	10×12	100	+10 percent to – 10 percent
ii)	8×10	80	
iii)	6×8	60	

8.5 Rock fall netting shall be manufactured with a 10×12 , 8×10 or 6×8 mesh type (*see* Fig. 7) having a nominal mesh opening size as per Table 9.

8.6 Sack Gabion shall be manufactured with a 10×12 , 8×10 mesh type (*see* Fig. 8) having a nominal mesh opening size as per Table 9.

8.7 Vertical facing units of reinforced soil structure shall be manufactured with a 10×12 , 8×10 mesh type (*see* Fig. 9) having a nominal mesh opening size as per Table 9.

8.8 Inclined facing units of reinforced soil structure shall be manufactured with a 10×12 , 8×10 mesh type (*see* Fig. 10) having a nominal mesh opening size as per Table 9.

8.9 The width and length of the gabions, revet mattresses, sack gabions, vertical and inclined facing units of reinforced soil structure as manufactured shall not differ more than ± 5 percent from the ordered size prior to filling. (Typical gabions, revet mattresses, sack

gabions, vertical and inclined facing units of reinforced soil structure sizes are shown in Tables 1, 2, 3, 4, 5 respectively.)

8.10 The height of the gabions, revet mattresses, sack gabions, vertical and inclined facing units of reinforced soil structure as manufactured shall not differ more than +10 percent, if the height is less than or equal to 0.3 m and shall not differ more than ± 5 percent if the height is more than 0.3 m from the ordered size prior to filling.

8.11 The tolerance on the roll length of rock fall netting shall be +1 m to 0 m. The tolerance on the width shall be $\pm D$ (mesh size). See Table 6 for the typical sizes of netting rolls.

8.12 Mesh Opening Tolerances

Tolerances on the hexagonal, double-twisted wire mesh opening shall not exceed +10 percent to –10 percent on the nominal dimension D values mentioned in Table 9.

9 WORKMANSHIP

Wire of proper grade and quality, when fabricated in the manner herein required, shall result in a strong, serviceable mesh type product have substantially uniform openings. It shall be fabricated and finished with good workmanship as determined by visual inspection and shall conform to this standard.

10 SAMPLING

10.1 Samples for determining the mechanical and physical properties of double-twisted wire mesh shall be in accordance with the samples, dimensions, and requirements described in 12.

10.2 Samples for determining the mechanical and physical properties of coated steel wire used for mesh, lacing wire and stiffeners shall be selected at random from wire coils used for manufacturing.

11 NUMBER OF TESTS

11.1 The tensile strength, galvanizing weight, and polymer coating thickness of the coated steel wire used in the fabrication of mesh, lacing wire and stiffeners shall be certified by the steel wire/Polymer coated steel wire producers for conformance to the requirements of 6, 7 and 8.

11.2 A minimum of three tests each for conformance to strength of galvanized steel wire mesh parallel to twist and perpendicular to twist shall be performed. A retest for conformance with the aforementioned strength tests shall be required when changes of the physical characteristics of the mesh products occur.

For galvanized steel wire with polymer coating, follow the same requirements as for the galvanized steel wire mesh. The results of all three tests shall meet the requirements of Table 4.

12 TEST METHODS

12.1 Tensile Strength of Wire Mesh Panel

The wire mesh specimens shall be representative of proper field construction as to materials, mesh geometry, and workmanship, and shall be as large as practical to minimize the effect of variations. The tests shall be run with the load applied parallel to the axis of the twist and repeated on a separate test specimen with the load applied perpendicular to the axis of the twist.

12.1.1 Place the mesh into the machine grips such that the gripped mesh will be maintained in the mesh geometry characteristic of field use. The specimen of approximately 0.8 m width and 0.5 m height shall be tested. The effective width to be considered for test specimen shall be the distance between two extreme gripping points. The specimen should extend by at least one mesh repetition beyond the extreme gripping points on either side. However, specimen should not extend more than two mesh repetitions beyond extreme gripping points. The mesh shall be pre-loaded to 10 percent of the specified minimum strength and machine head travel stopped. The mesh gauge dimensions shall be recorded at this time and taken as the initial dimensions of the specimen where such dimensions are required. The loading shall then continue uniformly maintaining the displacement rate of 75 to 100 mm/min, until first fracture or unwrapping of an individual wire in the system occurs. The distortion of the mesh or changes in gauge length shall be measured to accuracy consistent with reporting the percent elongation to the nearest 0.5 percent.

12.2 Punch Test

Perform punch tests as specified in APPENDIX 2500/I clause no. 5.2 Punch Test of MORTH 2013 'Specifications for Roads and Bridges'.

12.3 Metallic Coating Mass

Perform coating mass tests and adhesion tests as specified in IS 4826 or IS 12757 as applicable.

12.4 Polymer Coating Thickness

The thickness of the Polymer coating shall be determined on a randomly chosen individual piece of wire removed from the coil at 3 places 1 m apart.

Measure the diameter of the galvanized steel wire with Polymer coating with a micrometre. Determine the thickness of the Polymer coating by stripping the Polymer coating from the wire and measure the reduced diameter with a micrometre. The thickness of the coating is the difference between the diameter of the galvanized steel wire with Polymer coating and the measured diameter of the galvanized steel wire divided by two. The average value of thickness of the coating, shall be in accordance with 8.2 and Tables 1, 2, 3, 4, 5 and 6. When removing the Polymer coating

by stripping, care to be taken, not to remove any of the metallic surfaces.

12.5 Polymer Coating — Resistance to Sodium Chloride Solution

12.5.1 Apparatus

12.5.1.1 *Chamber or room*, where the temperature is between 5°C and 30°C.

12.5.1.2 *Scales*, accurate to within 0.1 mg.

12.5.1.3 Test tube

12.5.2 *Reagents* — Saturated sodium chloride solution.

12.5.3 Preparation of Test Specimen

Bend a 200 mm long piece of polymer coated wire into a U-shaped that it can fit in to the test tube.

12.5.4 Procedure

Weigh the test specimen and put it in the test tube. Fill the test tube with the sodium chloride solution such that the ends are 5 mm above the solution. After at least 60 h remove the test specimen from the solution, wash it, dry it and reweigh it. Check for compliance to 7.2 (d).

13 MARKING

13.1 Each finished product shall be marked legibly and indelibly with the following details on a metal tag:

- Name of manufacturer;
- Product type (gabions, revet mattresses, sack gabion, soil reinforcement facia units or rock fall netting);
- Mesh type (10 × 12, 8 × 10 or 6 × 8);
- Class of coating;
- Mesh wire size, in mm;
- Size, in m (length × width × height — For gabions, revet mattresses and soil reinforcement facia units, length and diameter for sack gabion and length × width — for netting rolls);
- Batch No. or date of manufacturing; and
- Any other information as specified by the purchaser.

13.2 BIS Certification Marking

The details available with the Bureau of Indian Standards.

13.2.1 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act, 2016* and the Rules and Regulations made thereunder.

The details of the conditions under which the licence for use of the Standard Mark may be granted to manufacturers or producers, may be obtained from the Bureau of Indian Standards.

13.3 The following information shall be supplied by the purchaser/indenter:

- a) Gabions, revet mattresses, sack gabions, soil reinforcement facia units or rock fall netting;
- b) Mesh type (10×12 , 8×10 or 6×8);
- c) Class;
- d) Mesh size and mesh wire diameter, in mm;
- e) Size, in m (length $\times$ width $\times$ height — For Gabions, revet mattresses, soil reinforcement facia units, length and diameter for sack gabions and length $\times$ width — for netting rolls);
- f) IS number and year of issue;
- g) Quantity (number of units) for each class and size;
- h) Manufacturer's certificate, if required (*see* 14); and
- j) Any other requirement.

14 CERTIFICATES

When specified in the purchase order or contract, a manufacturer's certificate shall be furnished to the purchaser that the material has been manufactured, tested, and inspected in accordance with requirements of this standard and has been found to be conforming to the requirements. When specified in the contract or purchase order, reports of the test results for each batch supplied shall be furnished.

15 INSTALLATION MANUAL

The manufacturer shall supply installation manual for installation of the product.

ANNEX A

(Informative)

Table A.1 Description of environment of installation site, coating wire requirements

Site Environment level ^a (in accordance with ISO 9223, Table 1)	Organic coating material	Coating	Class ^b (EN 10244-2)	Assumed Working Life of the Product (years)
Low Aggressive: (C 2)				
Dry conditions	—	Zinc	A	25
Temperate zone, atmospheric environment with low pollution, e.g. rural areas, small towns (over 100 m above sea level). Dry or cold zone, atmospheric environment with short time of wetness, e.g. deserts, sub-arctic areas	—	Zn 95 percent/Al 5 percent alloy	A	>50
	—	Zn 95 percent/Al 10 percent alloy	A	>120
Medium aggressive: (C 3)				
Dry conditions	—	Zinc	E	10
	—	Zn 95 percent/Al 5 percent alloy	A	25
	—	Zn 95 percent/Al 10 percent alloy	A	>50
Temperate zone, atmospheric environment with medium pollution or some effect of chlorides, e.g. urban areas, coastal areas with low deposition of chlorides, e.g. subtropical and tropical zone, atmosphere with low pollution	Polyvinyl Chloride (PVC)	Zn 95 percent/Al 5 percent alloy	A	120
	Polyamide (PA6)		E	
	Polyvinyl Chloride (PVC)	Zn 95 percent/Al 10 percent alloy	A	>120
	Polyamide (PA6)		E	
High aggressive: (C 4)				
Wet conditions	—	Zn 95 percent/Al 5 percent alloy	A	10
	—	Zn 95 percent/Al 10 percent alloy	A	25
Temperate zone, atmospheric environment with high pollution or substantial effect of chlorides, e.g. polluted urban areas, industrial areas, coastal areas, without spray of salt water, exposure to strong effect of de-icing salts, e.g. subtropical and tropical zone, atmosphere with medium pollution industrial areas, coastal areas, shelter positions at coastline.	Polyvinyl Chloride (PVC)	Zn 95 percent/Al 5 percent alloy	A	120
	Polyamide (PA6)		E	
	Polyvinyl Chloride (PVC)	Zn 95 percent/Al 10 percent alloy	A	>120
	Polyamide (PA6)		E	
Very High aggressive: (C 5)				
Wet conditions	Polyvinyl Chloride (PVC)	Zn 95 percent/Al 5 percent alloy	A	120
	Polyamide (PA6)		E	
Temperate and subtropical zone, atmospheric environment with very high pollution and/or important effect of chlorides, e.g. industrial areas, coastal areas, shelter positions at coastline	Polyvinyl Chloride (PVC)	Zn 95 percent/Al 10 percent alloy	A	>120
	Polyamide (PA6)		E	
Extreme aggressive: (C X)				
Subtropical and tropical zone (very high time of wetness), atmospheric environment with very high pollution SO ₂ (higher than 250 µg/m ³) including accompanying and production ones and/or strong effect of chlorides, e.g. extreme industrial areas, coastal and off shore areas, occasionally contact with salt spray.	Polyvinyl Chloride (PVC)		A	
	Polyamide (PA6)	Zn 95 percent/Al 10 percent alloy	E	>120

Working life (Product): The period of time during which the performance of a product will be maintained at a level that enables a properly designed and executed works to fulfill the essential requirements (i.e the essential requirements of a product meet or exceed minimum acceptable values without incurring major cost of repair and maintenance). The working life of a product depends on the inherent durability and normal installation and maintenance.

A clear distinction has to be made between the assumed economically reasonable working life for a product (also called: design working life), which underlies the assessment of durability in technical specifications, and actual working life of product in a works. The latter depends on many factors beyond the control of producer, such as design, location of use (Exposure), installation, use and maintenance.

The assumed working life can thus not be interpreted as the guarantee given by the producer.

Technical specifications writers will have to view about the “normal” working life of the products that they deal with. The assumed working life of a product should take account of the assumed working life of the works, ease and cost of repair or replacement of the product, maintenance requirements and exposure conditions.

Note: The table is not applicable for mesh used for paving reinforcements.

^{a)} Gabion products immersed in water (saline and/or polluted water) and/or in contact with alkaline solutions, or gabions which are subject to abrasive conditions (sand storms, metal particles etc) shall be metallic coated with plastic coating or shall be made from stainless steel wire.

^{b)} There exists more advanced metallic coatings with superior corrosion protection. In terms of salt spray performance (EN ISO 9227), it means that the mesh samples shall not show more than 5 percent of DBR (Dark Brown Rust) after 2 000 h of exposure on the surface. When subjected to test in sulphur dioxide environment (ISO 6988), mesh samples shall not show more than 5 percent of DBR (Dark Brown Rust) after 56 cycles of discontinuous test on the surface. So, assumed working life values will be improved depending on the prevailing conditions.

ANNEX B*(Foreword)***COMMITTEE COMPOSITION**

Wire Ropes and Wire Products Sectional Committee, MED 10

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Directorate General of Mines Safety, Dhanbad	SHRI D. B. NAIK (Chairman) SHRI VIJAY KUMAR KAVALI (<i>Alternate</i>)
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